# Silage fermentation characteristics and contents of condensed tannins of four different legumes

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## Introduction

Condensed tannins (**CT**) are bioactive compounds in legumes which, at low pH, form complexes with proteins and these complexes decelerate or even prevent ruminal protein degradation. However, less is known about the ensiling process of tanniniferous legumes like sainfoin and birdsfoot trefoil and the development of the content and fractions of CT during the conservation of these legumes. Additionally, there are indications that CT may inhibit the proteolysis in the silage (Salawu et al., 1999; Lorenz et al., 2010). The aim of the present study was to determine the ensiling ability of different CT-containing legumes and monitor changes in CT-content and its fractions during wilting and ensiling.

## Material and Methods

Four legumes [lucerne (Sanditi), sainfoin (Perly) and two birdsfoot trefoil (**BFT**) cultivars (Polom, Bull)] were harvested at the stage of early flowering from three different locations (batches) in the field. After 24 h of wilting, the legumes were chopped (1-2 cm) and ensiled without additives in three 1.5L and one 0.5L silos containers per batch per legume. The containers were stored for 86 days in a dark room at room temperature. To determine silage fermentation and silage quality, gas losses were monitored by weighing the silos every week and pH was determined by opening one silo per silage and batch on day 3. After 86 days the remaining containers were opened and nutrient composition, volatile fatty acids and alcohols were analysed. Total, extractable, protein- and fiber-bound CT were analysed in the fresh, wilted and ensiled samples using the HCl-butanol method by Terrill et al. (1992).

## Results and Discussion

The dry matter (DM)-contents of the silages amounted 49.8 for Lucerne, 37.2 for sainfoin and 35.2 respectively 35.4 % for the two BFT. The maximal gas-losses amounted to 1.8% (BFT Polom; BFT





Bull) and were nearly the same for sainfoin (1.6%) and lucerne (1.2%). The average pH at day 3 after ensiling was 5.9, 5.4, 5.2 and 5.2 for lucerne, sainfoin, BFT Polom and BFT Bull respectively. The low gas-losses and the average pH at d 3 indicates a normal course of silage fermentation. After 86 days of ensiling, the amount of the three volatile fatty acids (**VFA**) lactic, acetic and butyric acid were greater for sainfoin (70.0 g/kg DM), BFT Polom (93.5 g/kg DM) and BFT Bull (86.8 g/kg DM) compared to lucerne (62.5 g/kg DM). This difference was mainly due to the DM-contents and fermentation intensity, respectively .The content of lactic acid (50.7, 61.9, 75.5 and 68.2 g/kg DM for lucerne, sainfoin, BFT Polom and BFT Bull, respectively) and acetic acid (10.2, 7.2, 16.2 and 16.8 g/kg DM for lucerne, sainfoin, BFT Polom and BFT Bull, respectively). The content of ethanol detected in lucerne silage (1.6 g/kg DM) was also less compared to sainfoin (3.6 g/kg DM), BFT Polom (2.7 g/kg DM) and BFT Bull (3.0 g/kg DM). In addition the content of butandiol were higher in CT-containing legumes and the content of propandiol was nearly the same(3.4, 1.1, 1.4 g/kg DM for butandiol and 0.0, 0.1, 0.2 g/kg DM for propandiol in sainfoin, BFT Polom and BFT Bull, respectively) compared to lucerne (0.5 g/kg DM butandiol and 0.1 g/kg DM propandiol). The contens of acetic and lactic acid and the contents of propandiol and ethanol in sainfoin and BFT silage were greater compared to results reported by Theodoridou et al. (2011) and Hymes-Fecht et al. (2013). However, neither Theodoridou et al. (2011) nor Hymes-Fecht et al. (2013) mentioned the time periode of ensiling which can have an effect on acid production as well as on the chemical composition of the ensiled material (Pahlow and Hünting, 2011).

With 173 g/kg DM the CT content of the fresh sainfoin sample was much greater compared to BFT Bull (35 g/kg DM) and BFT Polom (23 g/kg DM). The CT content of the fresh sainfoin was also greater compared to that observed in a previous study, where 15 accessions of sainfoin were tested and CT contents ranged from 47 to 68 g/kg DM (Azuhnwi et al., 2011). Lower contents were also reported by Lorenz et al. (2010), who found levels ranging from 60 to 67 g CT/kg DM in three different sainfoin cultivars. These differences support conclusions of Azuhnwi et al. (2011) that CT contents of sainfoin is variable as it is strongly influenced by factors like cultivar, cultivation site and harvest time. During wilting and ensiling the CT content of sainfoin decreased to153 and 137 g/kg DM respectively, whereas the content of BFT remained unchanged (Bull 35 and 34 g/kg DM; Polom 24 and 22 g/kg DM, respectively). These findings are consistent with those of Scharenberg et al. (2007a) for sainfoin but not for BFT where CT content was lower in the fresh compared to the ensiled material.

After wilting, CT were predominately present in protein- and fibre-bound forms whereas in the fresh samples the majority of CT was found in the soluble fraction. Ensiling even amplified this shift. These shift was also found by Scharenberg et al. (2007b) for sainfoin and BFT, when fresh and ensiled forage was compared. Lorenz et al. (2010), who analysed three different sainfoin varieties, found also a decrease in the fraction of the extractable tannins from the fresh to the ensiled sainfoin.

## Conclusions

The silages showed a good fermentation quality. The results confirm that prewilted legumes can be ensiled without additives. Wilting and especially ensiling caused a shift in the proportions of the soluble, protein- and fibre-bound fractions in all tested legumes. This shift could result in a lower protein degradability in the rumen for ensiled compared to green material and enhance the amount of available protein in the small intestine.

*Acknowledgements*

*EU Marie Curie Initial Training Network ('LegumePlus'; PITN-GA-2001-289377)*

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